Less-Complex Method of Classifying MPSK

Nearly optimal performance can be obtained with less computation.

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An alternative to an optimal method of automated classification of signals modulated with *M*-ary phase-shift-keying (*M*-ary PSK or MPSK) has been derived. The alternative method is approximate, but it offers nearly optimal performance and entails much less complexity, which translates to much less computation time.

Modulation classification is becoming increasingly important in radio-communication systems that utilize multiple data modulation schemes and include software-defined or software-controlled receivers. Such a receiver may "know" little *a priori* about an incoming signal but may be required to correctly classify its data rate, modulation type, and forward error-correction code before properly configuring itself to acquire and track the symbol timing, carrier frequency, and phase, and ultimately produce decoded bits. Modulation classification has long been an important component of military interception of initially unknown radio signals transmitted by adversaries. Modulation classification may also be useful for enabling cellular telephones to automatically recognize different signal types and configure themselves accordingly.

The concept of modulation classification as outlined in the preceding paragraph is quite general. However, at the present early stage of development, and for the purpose of describing the present alternative method, the term "modulation classification" or simply "classification" signifies, more specifically, a distinction between *M*-ary and *M*'-ary {Internal Editorial Note: prime mark, not apostrophe} PSK, where *M* and *M*' represent two different integer multiples of 2.

Both the prior optimal method and the present alternative method require the acquisition of magnitude and phase values of a number (*N*) of consecutive baseband samples of the incoming signal + noise. The prior optimal method is based on a maximum-likelihood (ML) classification rule that requires a calculation of likelihood functions for the *M* and *M*' hypotheses: Each likelihood function is an integral, over a full cycle of carrier phase, of a complicated sum of functions of the baseband sample values, the carrier phase, the carrier-signal and noise magnitudes, and *M* or *M*'. Then the likelihood ratio, defined as the ratio between the likelihood functions, is computed, leading to the choice of whichever hypothesis — *M* or *M*' — is more likely.

In the alternative method, the integral in each likelihood function is approximated by a sum over values of the integrand sampled at a number, *I*, of equally spaced values of carrier phase. Used in this way, *I* is a parameter that can be adjusted to trade computational complexity against the probability of misclassification. In the limit as $I \to \infty$, one obtains the integral form of the likelihood function and thus recovers the ML classification.

The present approximate method has been tested in comparison with the ML method by means of computational simulations. The results of the simulations have shown that the performance (as quantified by probability of misclassification) of the approximate method is nearly indistinguishable from that of the ML method (see figure).

This work was done by Jon Hamkins of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.techbriefs.com/tsp*** *under the category.*
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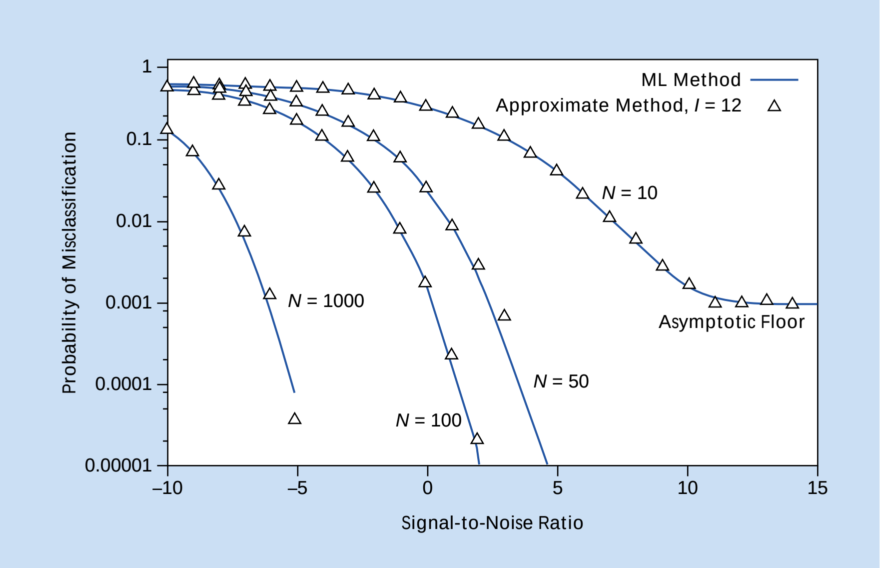
figure caption:
(2 columns)
Performances of the ML and Approximate Methods were computed in computational simulations for a case of noncoherent reception of signals that had equal probability of being binary PSK or quaternary PSK.



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